IN THE SPECIFICATION

Page 11, line 33 to page 13, line 24 have been amended as follows:

The invention ~~comprise~~ further **comprises** a process of recycling solution containing detergent and water in a cleaning device or a cleaning device in combination with a filter station ~~as defined in the claims 1-22. This process is defined in claims 23-38~~.

In the process according to the invention, clean solution is transported from the clean solution tank to the cleaner head and through the supply opening of the cleaner head onto the surface to be cleaned e.g. a floor or a carpet. The amount of solution transported through the supply opening may preferably be from 0.1 to 20 l/min. Used solution is recovered through the recovery opening of the cleaner by use of a suction means, such as a pump or a suction device, and the recovered dirty solution is transported to the dirty **solution** tank. It is preferred that at least 60% by [[vol.]] **volume** of the solution is recovered. In some preferred embodiments of the invention, up to about 100% of the solution can be recovered. In order to recover as much dirty solution as ~~possibly~~ **possible,** the solution on the surface to be cleaned may be collected by use of a squeegee mounted on the cleaner head. Such arrangements are generally known from the art.

Dirty solution is transported from the dirty solution tank through a filter unit comprising a cross-flow filter. From this filter unit, concentrated dirty solution is returned to the dirty solution tank, and filtered cleaned solution is transported to the clean solution tank for reuse. The pressure on the dirty solution side of the filter unit may [[e.g.]] be 0.5-10 bar. A typical flow rate through the cross-flow filter is 0.1-4.0 l/min/m^2.

With regular ~~intervals~~, **intervals,** preferably from 1 to 20 times per minute, more preferably from 1 to 10 times per minute, the filter unit is preferably regenerated by pumping clean solution from the clean solution tank in a back-flush through the filter unit.

The duration of each step of pumping clean solution from the clean solution tank in a back-flush through the filter unit may [[e.g.]] have a duration of from 0.5 to 10 seconds. [[A]] **An** automatic control unit may preferably regulate the intervals and duration of the back-flush procedure.

The cleaned solution may preferably be recirculated to the clean solution tank at a flow of [[from]] **about** 0.1 to 1,000 l/hr. The optimal speed of recirculation ~~depend~~ **depends** largely on the solution consumption of the cleaning [[devise]] **device** under operation. Preferably, the speed of recirculation **of** the clean solution should correspond to the speed of consumption.

The concentration of detergent and/or ~~tretment~~ **treatment** chemicals in the solution depend on the type of detergent/treatment chemicals, the type of surface that is to be cleaned/treated, and the type of dirt to be removed from this surface. In most situations, however, a detergent solution having a detergent concentration in the range 0.001 - 25 % by weight is suitable for cleaning surfaces.

DESCRIPTION OF THE DRAWINGS

The invention is described in further ~~details~~ **detail** with reference to the following figures and examples:

Page 13, line 34 to page 14, line 6 have been amended as follows:

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Sedimentation of dirt

Debris or "Dirt", collected by a floor scrubber using conventional cleaning solutions, has been ~~analysed~~ **analyzed** from a number of different locations. It was found that up to 83% (% w/w) of the dirt particles consists of particles < 20 μm. A summary of the findings from 4 different locations is shown in table 1:

Page 15, line 6 to page 16, line 4 have been amended as follows:

From Table 1**,** it was concluded that a significant part of "dirt" consists of particles smaller that 20 μm. From table 2, it can be seen that it is quite normal that dirt collected from floors comprises relatively large amounts (e.g. 10-20 g/1) of particles smaller that 20 μm. Trying to clean [[a]] such **a** dirty solution using [[an]] ordinary in-depth filters alone will lead to very frequent replacement**,** and filters having very large filter areas would be necessary, assuming that the cleaning ~~devises~~ **devices** typically have a 0.5-10 1/min solution consumption.

Hereafter**,** it was investigated how the "dirty solutions" behaved in a sedimentation test in a standard conical beaker. The starting solution (in the clean solution tank) in all tests was a clear solution. The results are shown in table 3:

Location		Sedimentation characteristics
High Voltage Lab.	Heavy industry floor	~~72hours:~~ **72 hours:** No clear phase
High Voltage Lab.	Heavy industry floor	3.000rpm/10 min: No clear phase.
High Voltage Lab.	Heavy industry floor	4.000rpm/5 min: **[[no]]** **No** clear phase
Engineering Production	Light ~~Industry~~ **industry** painted floor	72 hours: No clear phase
Volvo (Ballerup)	Auto repair shop (tile floor)	72 hours: No clear phase
Kvickly	Supermarket hard floor	120 hours: No clear phase

Table 3: Sedimentation test in a conical beaker (1000 ml) **[[incl.]]** **including** centrifugation test.

Page 16, lines 10-20 have been amended as follows:

Hereafter**,** it was tested if **[[a]]** centrifugation could clean the liquid. The "dirty solution" from the "Heavy industry floor" was centrifuged using 3.000 rpm (10 min) and 4.000 rpm (5 min). Still**,** it was not possible to obtain a clear phase in the centrifuged liquid in either case.

A preferred cleaning system of the invention

[[Fig.]] **Figs.** 1 and 2 show schematically a preferred cleaning device, and in particular**,** the recycling system thereof.

Page 17, line 12 to page 19, line 21 have been amended as follows:

When the recycling system works in its first mode, dirty solution is sucked through **the course screen** F1 using the pump P1, and a solution stream flows through pipeline D1. **The course screen** F1 stops large particles from entering the membrane filter unit F2 and valves V3 and V4, and the filter unit and the valves are consequently prevented from clogging. After passing through pipeline D1, the solution flows through membrane filter unit F2. The membrane filter unit ~~comprise~~ **comprises** a cross-flow membrane as it is shown in fig. 2. The solution flows into the filter unit F2 through opening 01 on the dirty side A, where it passes along the membrane M. Some water and detergent ~~passes~~ **pass** through the membrane **M** and enter the clean solution side B, and exit the filter unit F2 through opening 03 into pipeline C1. The concentrated dirt and solution mixture leaves the filter unit F2 through opening 02 into pipeline D2. When the recycling system works in its first mode, valve V3 is closed while the passing through valve V4 is adjusted so as to obtain a ~~suitably~~ **suitable** pressure difference over the

membrane **M** e.g. 0.5 to 10 bar. The dirty solution concentrate returns to the dirty solution tank ~~trough~~ **through** pipeline D3. Valve Vl is open, and the solution from pipeline Cl flows freely through valve V1 and the check valve V5, which stops air from entering the filter unit F2. The solution from pipeline C1 flows into the clean solution tank. Valve V2 is closed and pump P2 is turned off when the system is working in its first mode. The size of solution stream in pipeline C1 compared to the size of solution stream in pipeline D2 is determined by the back-pressure created by valve V4 and the resistances of the membrane, so that any settlement of dirt on the membrane is avoided. The back-pressure is chosen according to the tolerance of the membrane M, and the establishment of a cross-flow through pipeline D2 large enough to transport all dirt entering the filter through pipeline D1 back to the dirty solution tank S2.

For regular cleaning of the membrane **M,** a back-flush mechanism is used. This back-flush mechanism is operating when the system is working in its second mode. When the back-flush mechanism is turned on**, valve** V3 is opened to reduce the trans-membrane pressure, **valve** V1 is closed, **valve** V2 is opened and **pump** P2 turned on. All of the solution stream passing through pipeline D1 then flows directly through **filter unit** F2 and into pipeline D2. From pipeline D2. [[it]] **the solution stream** splits into pipelines D3 and D4, from where it flows into the dirty solution tank S2. The pump P2 is started, and a clean solution stream flows from the clean solution tank **S1** [[flows]] into the pipeline C2, where it ~~is passing~~ **passes** through check valve V6 and the open valve V2. The clean solution stream from pipeline C2 flows into the filter unit F2 through opening 04 on the clean side B of the membrane M, and it passes along the membrane M. The clean solution passes through the membrane **M** and enters the dirty solution side A. When the clean solution passes through membrane M from the clean side **B** to the dirty side **A,** the membrane **M** is regenerated. After having passed the membrane **M,** the solution flows**,** along with the dirty solution from pipeline D1**,** out in pipeline D2.

The construction and design of the membrane filter unit F2 is not crucial for the recycling system to work[[,]]**;** this is shown later on in example 5. The cross-flow operation of the filter is important and distinguishes this technology from used methods of in-depth filtration. Thus**,** it is ~~particular~~ **particularly** preferred that the membrane filter unit **F2** uses a cross-flow principle as it is illustrated on fig. 2. where water and detergent (and possibly treatment chemicals) ~~crosses~~ **cross** the membrane **M,** while dirt just passes along the membrane **M**.

Fig. 3 shows another preferred recycling system of a cleaning device according to the invention. The device is transported on wheels W[[,]] and is supposed to be moved in the direction ~~**showed**~~ **shown** by the arrow when [[it is]] in use. The recycling system comprises a clean solution tank S1' and a dirty solution tank S2'. The recycling system comprises a coarse screen Fl', a membrane filter unit F2', valves V1', V2', V3', V5' and V6'; pumps P1' and P2'; pump /suction device P3'; and pipelines CO', DO', D1', D2', D3', C1', and C2'.

Page 19, line 26 to page 21, line 12 have been amended as follows:

When starting using the cleaning device, the solution tank [[S1*]] **S1'** is filled with fresh solution. The solution flows through pipeline CO' from the solution tank S1', and down to a ~~**not shown**~~ cleaner head**, not shown**. Dirty solution is recovered using ~~**pump or suction**~~ **pump/suction** device [[P3]] **P3'**, and transported ~~**trough**~~ **through** pipeline DO' to the dirty solution tank S2'. A coarse screen F1'[[,]] is placed inside said dirty solution tank **S2'**.

When the recycling system works in its first mode, dirty solution is sucked through **course screen** F1' using the pump P1', and a solution stream flows through pipeline D1'. After passing through pipeline D1', the solution flows through membrane filter unit F2'. The membrane filter unit ~~**comprise**~~ **comprises** a cross-flow membrane **M** as it is shown in fig. 2 and described above. The clean filtered solution [[exit]] **exits** the filter unit F2' through pipeline C1'. The concentrated dirt and solution mixture leaves the filter unit F2' through pipeline D2'. When the recycling system works in its first mode, the **flow** passing through valve V3' is adjusted so as to obtain a ~~**suitably**~~ **suitable** pressure. The dirty solution concentrate returns to the dirty solution tank ~~**trough**~~ **through** pipeline D3'. Valve V1' is open, and the solution from pipeline C1' flows freely through valve V1' and the check valve V5', which stops air from entering the filter unit F2'. The solution from pipeline C1' flows into the clean solution tank **S1'**. Valve V2' is closed**,** and pump P2' is turned off when the system is working in its first mode.

For regular cleaning of the membrane**,** a back-flush mechanism is used. This back-flush mechanism is operating when the system is working in its second mode. When the back-flush mechanism is turned on **valve** V3' is adjusted to reduce the trans-membrane pressure, **valve** V1' is closed, **valve** V2' is opened and **pump** P2' turned on. All of the solution stream passing through pipeline D1' then flows directly through **membrane filter unit** F2' and into pipeline D2'. From pipeline D2', it flows via **pipeline** D3' into the dirty solution tank S2'. The pump P2' is started, and a clean solution stream flows from the clean solution tank **S1'** [[flows]] into the

pipeline C2', where it ~~is passing~~ **passes** through check valve V6' and the open valve V2'. The clean solution stream from pipeline C2' flows into the filter unit F2' on the clean side B of the membrane M, and it passes along the membrane M. The clean solution passes through the membrane **M** and enters the dirty solution side A. When the clean solution passes through membrane M from the clean side to the dirty side, the membrane **M** is regenerated. After having passed the membrane **M**, the solution flows**,** along with the dirty solution from pipeline [[D1]] **D1'**, out in pipeline D2'.

Example 1

Before a separation test**,** the turbidity (NTU) of the tap water and the solution with different detergent ~~consentrations~~ **concentrations** was measured using a turbidity meter. The turbidity of the cleaning solution as a function of cleaning agent concentration is shown in table 4.

Page 21, line 19 to page 22, line 8 have been amended as follows:

A floor scrubber (Model BR 1000 manufactured by Nilfisk Advance A/S) was equipped with a sandwich type coarse screen and a tubular type cross flow membrane filter type CFP-1-D-9A manufactured by A/G Technology Inc. The coarse screen had a 405/100 μm screen (wire mesh) . The coarse screen was built as two large filter bags placed inside one another with spacers around, and suction from the inside of the inner filter bag. A solution of 0.5% cleaning agent A (CAA) was used in the test. A "dirty solution" was collected by a floor scrubber in a warehouse storage area[[,]] and ~~analysed~~ **analyzed**. The ~~analysed~~ **analyzed** dirty solution was hereafter introduced in a membrane separator/filter. The experimental set-up used is shown in fig. 1.

It was found that more than 97% (% w/w) of the dirt particles consists of particles < 20 μm. A summary of the findings from this ~~locations are~~ **location is** shown in table 5.

Page 23, line 1 to page 24, line 10 have been amended as follows:

It can be seen that the quality (turbidity) of the filtered solution[[,]] is as good as tap water or the [[0,5%]] **0.5%** starting solution used. A particle free filtered solution that can be recycled directly[[,]] is clearly obtained.

Example 2[[.]]

The same floor scrubber [[incl.]] **including** a coarse screen and the same membrane as mentioned in example 1 was used. 40 litres of water [[was]] **were** mixed with 200 ml "CAA".

Floor cleaning in the warehouse storage area (see table 5) was performed. 28 litres of dirty water solution **[[was]]** **<u>were</u>** collected. The dirty solution was diluted with water to about 55 litres volume.

The concentration of "CAA" in the dirty solution (A) was now about 0.25% by **[[vol]]** **<u>volume</u>**. The surface tension of the dirty solution was measured. Two samples of the **[[the]]** dirty solution (A) was diluted with water to obtain, ~~respective~~ **<u>respectively</u>**, a 25% by **[[vol.]]** **<u>volume</u>** dilution with water and a 6% by **[[vol.]]** **<u>volume</u>** dilution with water of the dirty solution (A). Now recycling of the dirty solution was performed. The permeate was recycled back into the dirty solution tank. The surface tension of the filtered solution (A) was measured. ~~Further more~~ **<u>Furthermore,</u>** two samples of the filtered solution **[[was]]** **<u>were</u>** diluted with water to obtain, ~~respective~~ **<u>respectively</u>**, a 25% by **[[vol.]]** **<u>volume</u>** dilution with water and a 6% by **[[vol.]]** **<u>volume</u>** dilution with water of the filtered solution. The surface tension as a function of detergent concentration was thereby obtained. The surface tension of tap water was measured to be about 49 dyn/cm.

Now**<u>,</u>** about 100 ml CAA was added to the dirty solution tank, and the experiment was repeated. The surface tension of the dirty solution (B), the filtered solution (B) and the 25% by **[[vol.]]** **<u>volume</u>** and 6% by **[[vol.]]** **<u>volume</u>** dilutions thereof was measured. The dirty solution (B) had a concentration of about 0.43% of CAA.**[[.]]**

Finally**<u>,</u>** 50 ml CAA was added to the dirty solution tank**[[.]]<u>,</u>** and the experiment was repeated. The surface tension of the dirty solution (C), the filtered solution (C) and the 25% by **[[vol.]]** **<u>volume</u>** and 6% by **[[vol.]]** **<u>volume</u>** dilutions thereof was measured. The dirty solution (B) had a concentration of about 0.52% of CAA.

Page 25, lines 1-26 have been amended as follows:

From this table**<u>,</u>** it can be seen that the cleaning agent passes the membrane, and that only a certain amount of the cleaning agent is bound to the dirt. In this case**<u>,</u>** less than 5% of the cleaning agent is used by the dirt**<u>,</u>** and thus more than 95% can be recovered, filtered and recycled. Surprising in this case is that the recycling is limited only by the collection efficiency of solution from the floor.

<u>Example 3</u>**[[.]]**

In this example**<u>,</u>** the surface tension of different detergent/dirt/water solutions using different membranes has been investigated. ~~The results are shown in table 8.~~ The **[[test]]** **<u>tests</u>**

were performed by circulating artificial dirty solution through a stationary filtration system similar to the system on the cleaning device shown in fig. 1, wherein the cleaner head part was not present. The surface tension was measured in the clean solution before the dirt was added, b) after the dirt was added, and c) in the two tanks when the filtration was terminated (the filtered solution is returned to the clean solution tank and the concentrate is returned to the dirty solution tank). **The results are shown in table 8:**

Page 27, lines 3-8 have been amended as follows:

From table 8, it can be seen that the low surface tension of the starting solution (see column marked "Solution") is maintained in the clean recovered solution (see column "filtered sol.") . This is valid for a range of different commercial detergents. Also**,** different cross flow membrane configurations can be used.

Page 27, lines 15-35 have been amended as follows:

Example 4[[.]]

In this example**,** about 500 ml "CAA (CAA) " is mixed in about 105 litre tap water (TW). The solution (S1) is ~~approx.~~ **approximately** a 0.5% "CAA" solution. Solution "S1" is filled into the clean solution tank of a floor scrubber according to the invention. The floor scrubber used was a BR 1000 as used in example 1 which was equipped with a recycling system as it is ~~schematic~~ **schematically** shown in figure 1. The cross-flow separator used was a separator type CFP-1-D-9A.

The characteristics of the solution **[[was]]** **were** measured using both turbidity (NTU) and the surface tension (in dyn/cm) of the solution. Cleaning of a warehouse floor was performed for about 35 **[[min]]** **minutes**. A permeate flow of about 150 l/hr was obtained. Automatic back-flush in 2 sec/min was used. About 65 litres of filtered solution (FS1) **[[was]]** **were** produced**,** and about 40 litres ~~was remaining~~ **remained** in the dirty solution tank. The recycling system **[[incl.]]** **including** the back-flush system is shown in figure 1.

Page 28, line 11 to page 29, line 2 have been amended as follows:

Now**,** the 65 litres of the above filtered solution FS1 **[[was]]** **were** mixed with about 20 litres of water (TW) including about 75 ml CAA into the clean solution tank. The volume in the clean solution tank was now about 85 litres and the surface tension of the solution (S2) was measured to about 30 dyn/cm. Cleaning was performed for about 32 **[[min]]** **minutes** and about 80 litres of recovered and filtered solution (FS2) **[[was]]** **were** collected. Automatic back-flush

(2sek/30sek) was used. The surface tension of filtered solution FS2 was measured to about 32 dyn/cm.

Hereafter, the 80 litres of the above recovered solution RS2 **[[was]]** **<u>were</u>** mixed with about 20 litres of water (TW) including about 1.80 ml CAA into the clean solution tank. The volume in the clean solution tank was now about 100 litres and the surface tension of the solution (S3) was measured to about 30 dyn/cm. Cleaning was performed for about 31 **[[min]]** **<u>minutes</u>** and about 85 litres of filtered solution FS3 **[[was]]** **<u>were</u>** collected. A permeate flow of about 135 1/hr was obtained. Automatic back-flush (2sek/30sek) was used.

Page 29, lines 13-23 have been amended as follows:

From example 4, it was found that the cleaning solution could be recovered and filtered multiple times. The quality of the filtered cleaning solution FS3 after **<u>being recycled</u>** 3 times ~~recycling~~ was equal to the original solution S1. The chemical consumption for performing the cleaning was reduced by up to about 85% in this example. The solution consumption was also reduced about 85%. It is quite clear that the effective time that the floor scrubber can be used for cleaning is substantially increased. This is shown in figure 4. The amount of effluent discharged from the floor cleaning operation is also reduced.

Page 30, line 8 has been amended as follows:

<u>Example 5[[.]]</u>

Page 30, line 17 to page 31, line 12 have been amended as follows:

A floor scrubber as used in example 1 was filled with a 0.5 % solution of detergent CAA. As <u>a</u> separator, a membrane type CFP-1-D-9A was used. Samples were taken out of the stream from the separator to the clean solution tank after 0, 18 and 30 minutes after the scrubbing and recycling process was started, and further samples were taken from demineralized water without detergent, and dirty solution.

On a clean surface, an average gloss on five separate areas was measured<u>. **Then**</u>, **[[then]]** a 50 μm layer of the test samples of the solutions was tape-casted out on the areas. The surface was left to dry, and an average gloss was measured again afterwards.

In diagram 5, the gloss of the surface areas before and after is shown. It is seen that the dirty solution gives a high reduction in gloss (<30) while the filtered solution keeps the gloss (70-75). The solution quality of the filtered solution as a function of time can also be seen to be stable.